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CVD graphene growth on non-planar surfaces, a pilot investigation

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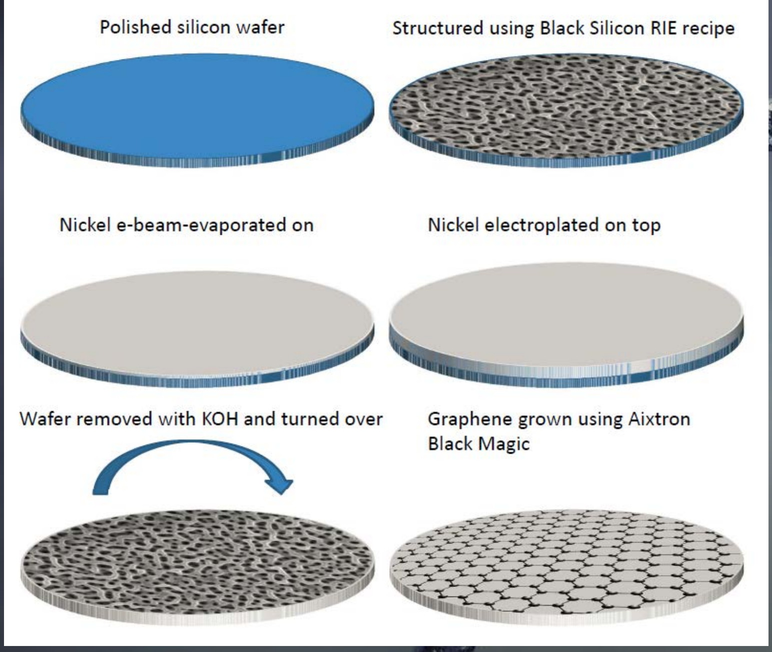
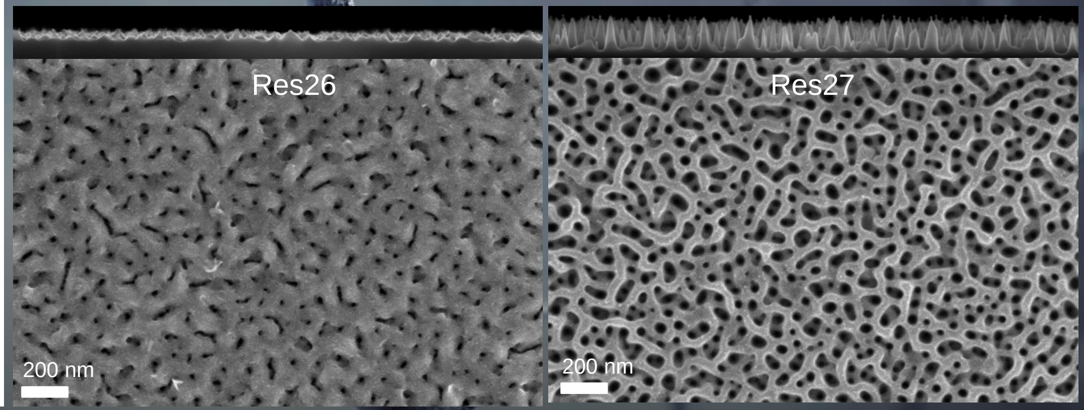
CVD graphene growth on non-planar surfaces, a pilot investigation

Adam C. Stoot, Alexander B. Christiansen, Martin B.B.S. Larsen, Peter Bøggild

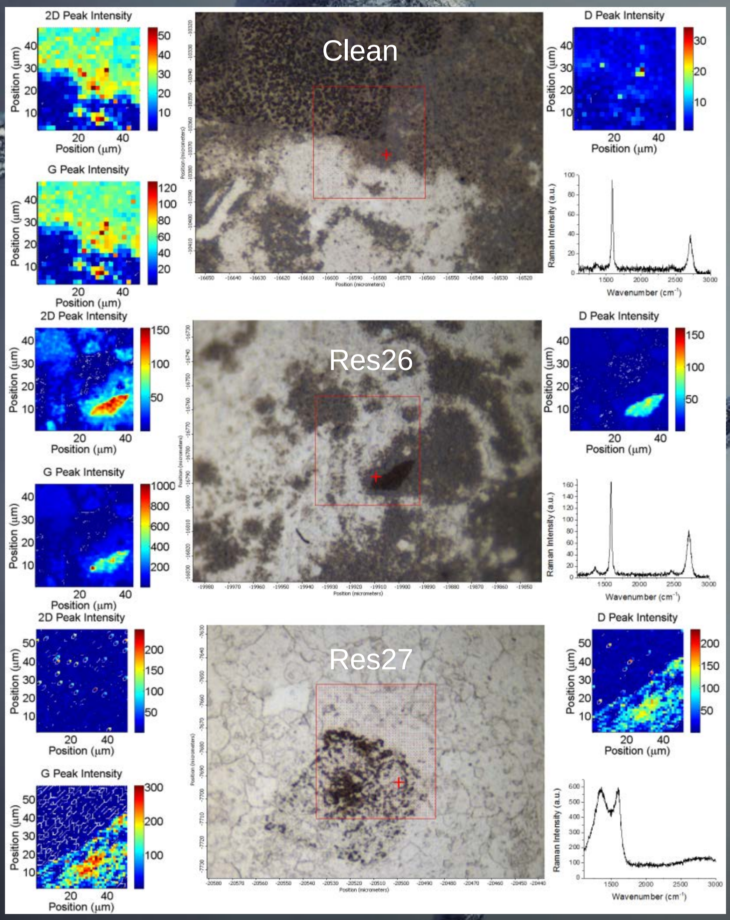
Fabrication



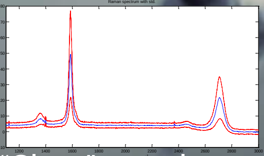
Surface roughness was created using an inverted black silicon technique. Firstly a blank silicon wafer was structured using a reactive ion etch (RIE) recipe with the desired surface structures. Nickel/Vanadium was sputtered onto the surface acting as a seed-layer for further nickel deposition in an electroplating bath. The original wafer was removed using KOH and the nickel structure from the nickel/silicon-interface was thus structured with the reverse of the black silicon RIE recipe used.



CVD Graphene Growth



Optical images of three sample surfaces with corresponding intensity maps for the three main Raman peaks as well as a representative spectrum. The flat surfaces are clearly covered with multilayers of graphene with few defects (barely visible D-peak).
The slightly rough surface (Res26) also shows a fair graphene quality with a slightly more pronounced defect peak.
Going to the very rough surface (Res27), graphene growth was absent. Amorphous carbon structures were instead visible, indicating that surface morphology can have a high impact on CVD graphene growth.



Here the “Clean” sample can be seen where all points are plotted with standard deviations. The variations comes from areas of higher and lower Raman intensity, but the ratios are similar.

The roughness of the samples types were characterised using AFM and SEM giving the arithmetic average of absolute values (R_a) and the rugosity (f_r).
The obtained values can be seen here

	Clean	Res26	Res27
R_a (nm)	1.75-1.81	10.3-12.4	9.36-10.8
f_r	1	1.6	4.7

The AFM tip can clearly not reach the bottom of the trenches, and here the rugosity estimated from the side-view SEM-images give a more concise picture.

The graphene was grown with a recipe using the following steps:
Annealing: H_2, 850°C, 5 mbar, 10 min
Growth: H_2+C_2H_2, 850°C, 10 mbar, 10 min
Cool-down: Vacuum, 0.5 K/s

Conclusion

Nickel surfaces with high nano-roughness were fabricated using an inverted black silicon technique. An Aixtron Black Magic CVD-system was used to grow graphene and its quality on different surfaces was compared using Raman spectroscopy. It was observed that the obtained graphene quality using said recipe is surface morphology dependent, and this should thus be taken into account when growing graphene on non-planar surfaces e.g. for coating purposes. Therefore, the effect of realistic surfaces and their impact on CVD graphene quality should be further investigated and an investigation is ongoing.

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